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SUBMERSIBLE WASTEWATER PUMPS
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SECTION 11100

SUBMERSIBLE WASTEWATER PUMPS

5-25 HORSE POWER DUPLEX

ACROSS THE LINE MAGNETIC

PART 1 - PRODUCTS

1.01 PUMP DESIGN

A. General:

Each pump shall be suitable for service in raw, unscreened sewage with 3 inch solids and shall conform to the requirements shown on the Drawings for flow rate, total dynamic head, horse power, voltage and phase. Pumps shall be as manufactured by Flygt or approved equal.

B. Qualifications of Manufacturers:

The pump manufacturer shall have a minimum of 10,000 heavy-duty submersible wastewater pumps installed and operating for no less than 5 years in the United States.

C. Design Requirements:

Furnish and install submersible non-clog wastewater pump(s). Each pump shall be equipped with a close coupled, submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, and 4 wire service with submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. The pump shall be supplied with a mating cast iron discharge connection and be capable of delivering the design flow and total discharge head. Each pump shall be fitted with stainless steel (304 S.S.) lifting chain or stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight. The design operating point shall be as near as possible to the best efficiency point of the selected motor.

D. Pump Design:

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel guide bars extending from the top of the station to the wet well mounted discharge connection. There shall be no need for personnel to

enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand.

Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the underside of the access frame.

E. Pump Construction:

Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

F. Cooling System:

Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pump-age, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket.

Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasket and bolted inspection ports of not less than 4"Ø located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104° F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40° C are not acceptable.

G. Cable Entry Seal:

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

1.02 PUMP MOTOR

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180° C (356° F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40° C (104° F) with an 80° C temperature rise and capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal

switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40° C (104° F) ambient and with a temperature rise not to exceed 80° C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of at least 65 feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

A. Pilot Cable:

The pilot cable shall be designed specifically for use with submersible pumps and shall be type SUBCAB (Submersible Cable). The cable shall be shielded, multi-conductor type with a chloroprene outer jacket and the tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 600 Volts and 90° C (194° F) with a 40° C (104° F) ambient temperature and shall be approved by Factory Mutual (FM). The cable length shall be adequate to reach the junction box without the need for splices.

B. Bearings:

The pump shaft shall rotate on at least three grease lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.

The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

C. Mechanical Seal:

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

The following seal types shall not be considered acceptable or equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to affect sealing shall be used. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. **The motor shall be able to operate continuously while non-submerged without damage while pumping under load.**

Seal lubricant shall be FDA Approved, nontoxic.

D. Pump Shaft:

Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel ASTM A 572 Grade 50 and shall be completely isolated from the pumped liquid.

E. Impeller:

The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, multiple vane, double shrouded non-clogging design, having long through-lets without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impeller(s) shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3-inch diameter solid. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.

F. Wear Rings:

A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel or brass ring insert that is drive fitted to the volute inlet. This pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

G. Volute:

Pump volute(s) shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

H. Protection:

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor, and activate an alarm.

I. Pump Motor Electrical Material:

1. All materials shall be new and shall conform to the applicable standard or standards where such have been established for the particular material in question. Publication and Standards of the organizations listed below are applicable to materials specified herein:
 - a. American Society for Testing and Materials (ASTM)
 - b. Underwriters' Lab (UL)
 - c. National Electrical Manufacturer Association (NEMA)
 - d. Insulated Power Cable Engineers Association (IPCEA)
 - e. Institute of Electrical and Electronic Engineers (IEEE)
 - f. Edison Electrical Institute (EEI)
 - g. National Fire Protection Association (NFPA)
 - h. American National Standards Institute (ANSI)
 - i. American Iron and Steel Institute (AISI)
2. Materials of the same type shall be the product of one manufacturer.
3. No IEC Rated Type "P" Device. Underwriters' Laboratory listed material shall bear U.L. Label. Also, no adjustable circuit breakers are to be used.

1.03 BACKBOARD

The backboard shall be constructed of pressure-treated lumber and fastened together with stainless steel hardware. The support posts shall be set a minimum of three feet (36 inches) below final grade with 3000 psi concrete. The 6" x 6" posts shall be level and plumb when the concrete is cured. The cross-piece boards shall be pressure treated lumber 2" x 8" boards free of knot holes. The backboard shall be (when assembled) a minimum of 12 feet horizontally and seven feet vertically above final grade, (greater height and/or width may be necessary in order to accommodate the mounting of **ALL** the requisite boxes, panels and etc., **ON ONE SIDE OF THE BACKBOARD ONLY**). Equipment mounting on both sides of the backboard **SHALL NOT BE ACCEPTABLE**. There shall be a sufficient number of intermediate support posts between the two end posts to accommodate mounted equipment weight without sagging, drooping, or tipping the backboard from true plumb and level.

In the event that the control panel and/or other devices are mounted too high for easy access to troubleshooting and maintenance points when standing at ground level, a moveable (without tools) step/catwalk shall be constructed from pressure treated lumber and positioned in front of the backboard. This step/catwalk shall be movable in

order to easily gain access to conduit and/or other potential maintenance-requiring items.

The cross pieces shall be assembled to the support posts with 3/8 – 16 stainless steel hex-head bolts, washers, split-ring lock washers, fender washers, and hex nuts. Nails, screws, lag-bolts, and etc., **SHALL NOT BE ACCEPTABLE**. The bolt heads shall be countersunk such that the mounting surface of the backboard presents a flush surface for equipment mounting. Each cross-piece shall be assembled to **ALL** support posts with two thru-bolt assemblies staggered so that the support post does not present a splitting potential created by straight-line bolting.

All backboard lumber shall be primed and painted with two coats of outdoor, UV resistant, Hunter Green paint. Backboards shall have a neat and professional finish when complete.

All equipment mounting to the backboard shall be accomplished with through-bolt methodology, utilizing stainless steel hex-head bolts, washers, lock washers, and hex nuts. Size of bolts to be determined by the equipment mounting supports, but in no case shall they be smaller than ¼-20 hardware. Screws, lag-bolts, nails, or any similar mounting hardware **SHALL NOT BE ACCEPTABLE**. The bottom side of any/all mounted equipment shall **NOT** be less than 30 inches above finished grade.

1.04 CIRCUIT BREAKER AND ENCLOSURE

A. Scope of Work:

Provide circuit breakers of ratings as indicated on the drawings and as specified herein.

B. Quality Assurance:

1. Acceptable Circuit Breaker Manufacturers shall include:

- a. General Electric Company
- b. Square D Company
- c. Westinghouse/Cutler Hammer
- d. Siemens

2. Circuit Breaker Compliance and Labels:

- a. Equipment shall comply with the latest applicable standards of NEMA PB-1 and UL 67.
- b. Where circuit breakers are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and UL service entrance label shall be provided.

C. Enclosures:

Provide circuit breakers, enclosures and auxiliary components of types, sizes and ratings indicated on the drawings. Enclosures shall be NEMA 3R, painted standard electrical light grey. Enclosure door/cover shall be provided with the means to be secured with a standard padlock.

D. Circuit Breakers:

Provide the size, type, and rating of circuit breakers as indicated in design. These breakers must be bolt-in type, heavy duty, quick-make, quick-break, thermal-magnetic molded case circuit breakers. **Breakers shall be large E-frame type. Q-frame breakers are not acceptable.** Multi-pole breakers shall be common trip. Anti-turn solder less, pressure type connectors shall be provided suitable for aluminum/copper wire.

E. Installation:

1. General:

- a. Label enclosed circuit breakers the same as specified for disconnect switch.
- b. Do not splice conductors in circuit breaker enclosure.
- c. Group and lace conductors within enclosure with nylon tie straps.

2. Adjust and Clean:

- a. Adjust operating mechanism for free mechanical movement.
- b. Touch-up scratched or marred surfaces to match original finish.

1.05 CONTROL PANEL

The pump manufacturer shall furnish an application appropriate pump control panel for each pumping station. The electrical control equipment shall be mounted within a

NEMA Type 3R enclosure constructed of stainless steel. The enclosure shall be equipped with drip lip, internally hinged aluminum (dead front) door, and a removable steel or aluminum back panel on which control components shall be mounted. The back panel shall be secured to the panel with collar studs. Operator controls shall be mounted on an aluminum inner swing panel (dead front). The enclosure door shall be hinged and sealed with a neoprene gasket. The outer door shall be equipped with a single handle-actuated three point latch mechanism which can be secured with a single standard padlock. Control panels controlling pumps less than 20 HP shall utilize across-the-line motor starters except where the technical drawings designate otherwise. Control panels controlling pumps 20 HP or greater shall utilize Solid State Soft Starters with bypass contactor circuitry or Variable Frequency Drives as required on the technical drawings.

A. Control Panel Requirements shall be as follows:

1. A pump station control panel shall be provided for each pumping station. The control panel shall respond to a level sensing processor and automatically start, stop, and alternate the pumps as well as announce an alarm in response to a high and/or low wet well level and provide a means for monitoring a 4 – 20 mA signal corresponding to the sensed wet well level. Dry contacts shall be provided for external device control and status/alarm conditions and annunciation. These features shall be programmable.
2. The pump control panel shall be of current system design and the standard production model of a currently active manufacturer with specific site modifications and/or additions. The panel shall meet UL standards and display a UL certification label.

B. Control System Components:

All control system components shall be new and consist of the standard product line of a currently active manufacturer. All motor branch circuit breakers and motor starting devices shall be of the highest industrial quality, and shall be securely fastened to the removable back panel with screws. The back panel shall be tapped to accept all equipment mounting screws. Self-tapping screws, sheet metal screws, and self-drilling screws SHALL NOT BE ACCEPTABLE. The manufacturer shall be capable of providing equipment/system start-up services and technical assistance. ALL equipment, work and material used for these panels shall be in compliance with all local, state, and federal guidelines; and shall conform to the standards set by NEC, NEMA, UL, and IEEE. All

components shall be listed by and labeled by Underwriters Laboratories where applicable.

1. Selector Switches – Heavy duty, oil-tight, two-position with center off, dead-front mounted Square D catalog number 9001KS43BH13 or equivalent with, as necessary, additional Square D catalog number 9001KA1 (or equivalent) contact sets.
2. Current Transformers (C.T.) – Where utilized, shall be installed to monitor the individual pump phase B current and provide a 4-20 mA representative output. Hawkeye Model 720 current transformer or equivalent shall be acceptable. Wiring of the C.T.'s shall be accomplished by City personnel.
3. Relays – Control and/or status indicating relays shall be 35mm din rail mounted type Square D catalog number 8501KP12, 8501KP13, 9050JCK, and 8501CA2KN (or equivalent) with applicable coil voltage rating and mounted in relay bases (as applicable) for ease of field replacement.
4. Terminal Blocks – Shall be heavy duty type/style Square D catalog number 9080GR6, 9080AB1AB8P35, and 9080LBA (or equivalent) rated for the current and voltage shown on the drawings.
5. Convenience outlet – A 120V, 20 Amp duplex receptacle shall be mounted on the control panel exterior.
6. Light Switch – A 120 volt 20 amp light switch inside a weatherproof box mounted to the side of the control panel to activate the area light.
7. Level Sensing Processor/Control System – The contractor shall provide a level sensing processor/control system (Siemens/Milltronics model "Hydroranger 200"), with the below listed minimum characteristics:
 - a. Level monitoring shall be accomplished with non-contacting sonic sensing suitable for use in the harsh and corrosive environment of raw sewage pumping stations and wet well(s), (NOTE: pressure transducer type sensing **SHALL NOT BE ACCEPTABLE**).
 - b. The system shall have a minimum of 4 programmable "A-Form" relay contact output sets and two "C-Form" programmable output contact sets for control of pumps, alarms, and other external equipment.
 - c. The system shall have a minimum of two programmable 4-20 mA signal outputs which are correspondent to the sensed level.

- d. The instrument shall have an LCD display for viewing applicable parameter readings in standard U.S. Customary Units (i.e. hours, feet, etc.).
 - e. The transducer shall be sealed and have a cable sufficiently long enough to preclude any wire splicing inside the wet well. The transducer itself shall be rated for operation in the harsh environment of a raw sewage wet well.
 - f. The level sensing/control system shall be provided with ALL accessory items necessary for complete system operation, maintenance, and programming to include applicable technical manuals and operator guides, hand-held programming device(s) and transducer.
 - g. The level sensing and processing unit itself shall be mounted in the pump control panel in a manner which allows viewing of the LCD display **AND** displaying all unit parameters without opening the “dead-front” door.
- 7a Mercury Float(s) – Two separate mercury switches enclosed in a smooth chemical resistant urethane or polypropylene casing suspended on its own cable shall be provided for operational usage within the raw sewage wet well. Each switch cable shall be of sufficient length to reach from its wet well position to the High/Low level and Transducer Junction Box **without splices**. Note that **ONLY 24VAC** power shall be acceptable for use inside the wet well. The remaining controls shall be designed to operate on 120volts/60Hz power.
8. Moisture Control - Each panel shall have a ventilation system whereby fresh air shall be drawn from outside the panel near the bottom and circulated across the panel components and exhausted to the outside through the opposite side of the panel near the top by means of fan(s) and louvers preventing condensation inside the panel. This forced air system shall be powered by 120 VAC and have an on/off switch.
9. Power Terminal - A main power terminal shall be provided for single point service termination of adequate size to accept the full size wire of the service required.
10. Wire – All interior wiring of the panel as well as interconnecting wiring to/from external devices shall be type **THHN STRANDED** of AWG size shown on the technical drawings unless specifically shown otherwise on the technical drawings. **IN NO CASE SHALL SOLID CORE WIRE BE ACCEPTABLE.**
11. Wire Markers - All control wiring to be numbered on both ends for ease of future trouble shooting. Lift station wires shall be marked, both ends, per standard Details S-21, S-22, S-23 & S-24.

12. Wire Connectors - As manufactured by Panduit or accepted equivalent.
13. Equipment Connections - As manufactured by Alpha Wire Corp., Belden Corp., General Electric Co., or accepted equivalent.
14. Circuit Breakers – Circuit Breakers shall be secured to the back panel by means of screws. The back panel shall be drilled and tapped to secure the circuit breakers. Circuit Breakers shall be Square D FAL or QUO (or equivalent) style. Size and number of poles shall be as shown on the technical drawings.
15. Transformers - Control Transformers shall be sized and provided in accord with the technical drawing and shall be Square D Type T (or equivalent). Power Transformers used to convert 480 VAC power to 240/120 VAC for use in control, lighting, and etc. circuitry shall be NEMA 3R enclosed and mounted **EXTERNAL TO THE CONTROL PANEL** on the backboard precluding the generation of heat inside the control panel.
16. Voltage/Phase Monitor – The voltage phase monitor relay shall sense loss-of-phase, phase unbalance, and phase rotation at a minimum. The phase monitor shall have a minimum of two dry “C Form” contact outputs. Phase Monitors shall be Diversified Electronics Model # SLA-230-ALE for 240 VAC stations or Diversified Electronics Model #SLA-460-ALE for 480 VAC stations (or equivalent).
17. Motor Starter(s):
 - a. For pump motors less than 20 HP, Across-The-Line NEMA rated, magnetic motor starters shall be Square D Class 8536.
 - b. For pump motors 20 HP or greater, a Square D Altistart Y-Range solid state motor starter with shorting contactor circuitry sized according to the technical drawing shall be utilized.
 - c. Where required by the technical drawing, a Square D Altivar variable frequency drive sized by the technical drawing shall be utilized.

C. Operating Controls and Instruments:

All operating control switches and instruments shall be securely mounted on the control “dead-front” inner door. All controls and instruments shall be clearly labeled to indicate function.

1. All circuit breakers shown on the technical drawing shall be provided and mounted within the control panel as required in the technical drawing.

2. All terminal blocks shall be of the screw clamp type and rated as indicated on the technical drawing.
3. All control wiring shall be THHN STRANDED and shall be routed through plastic wire way with snap-on covers except where specifically shown otherwise in the technical drawing.
4. SCADA (RTU) connections shall be provided.
5. Provisions shall be made for remote starting/stopping of pumps.
6. A back-up float High Level switch circuit which shall be designed **AND** wired such that its function is in electrical series with the Process Controller (Hydroranger 200) High Water alarm circuit).
7. Engraved nameplates shall be supplied for marking all components. The labels shall be attached with a 5 mil thick, 3M type adhesive. No foam tape will be acceptable. The labels shall be uniform in size with ¼" (inch) minimum letter sizes.
8. The control panel shall be equipped with an audible and visual alarm system consisting of an alarm horn (Federal Signal Corporation Model #350-120-30 or equivalent) and a red strobe/flashing beacon (Federal Signal Corporation Model #141 ST-120R or equivalent) indicating a Wetwell High Level condition. The control shall have a push-button alarm horn silence device mounted on the "dead front" door of the control panel. The flashing beacon/strobe shall be extinguished **ONLY UPON THE HIGH LEVEL CONDITION CLEARING**.

1.06 SCADA REMOTE TERMINAL UNIT (RTU) DEVICES

- A. SCADA RTU for ALL Stations (Duplex, Triplex, Variable Frequency Drive):

Controlwave MicroEnc with Modular input/output (I/O), 150 Mhz CPU, 1-Enet, 2-Rs232, 1-Rs485, (32) Digital Inputs points w/ remote termination, (16) Digital output points w/ remote termination, (16) Analog Input points w/ Remote termination, (4) Analog output points w/ remote termination. The SCADA unit shall be supplied as a complete unit including a Microwave Data Systems (MDS) SD9 900MHz Radio with 9600bps modem Rs-232, with network wide diagnostics option. The layout of the RTU shall be as shown in Bristol Drawing SVH2013.

See City of Savannah Standard Details S-21 or S-22 (for VFD), "Lift Station – SCADA RTU Controlwave Loop Wiring" for I/O connections.

B. Antenna:

Antenna - The antenna shall be 10DB Gain YAGI antenna and shall be furnished complete with all mounting hardware necessary for mounting to a 2" dia. mast (the 10DB Gain YAGI antenna is included in Bristol Babcock's standard duplex and triplex quote/price). Antenna shall be furnished such that the only field connection required by the Contractor shall be the antenna cable by means of a Type-N male connector. Because the antenna height and Azimuth are site specific it shall be the responsibility of the contractor to obtain the services of a qualified radio system firm to determine proper height and direction of antenna placement. Antenna shall be mounted in accordance with City of Savannah Standard Detail S-18 as applicable. The results of the radio path study, which shall be performed to determine the required antenna height and orientation, shall be submitted to the Owner for approval prior to installation of any equipment.

C. Radio Path Survey:

Radio Path Study Form, provided below, shall be faxed to the City of Savannah Radio Shop (912-351-3443) and emailed to jeff_jones@savannahga.gov for a determination of height and repeater choice.

Radio Path Study

Site: _____

Site Coordinates: _____

Date: _____

Technician: _____

Contractor: _____

Survey Results

	Kerry Street N32 02'29.1" W081 04'24.2 952.39375	South Side N31 56'33.3" W081 07'19.4" 952.08125	West Side N32 04'51.1" W081 15'12.2" 952.28125	Kerry MDS N32 02'29.1" W081 04'24.2 941.29375
Magnetic				
Statute Miles				
10'				
20'				
30'				
40'				
50'				
60'				
Other				

* Fill in all Blocks

Comments: _____

1.07 SAFETY AND DISCONNECTING SWITCHES

A. Scope of Work:

The requirements of this section apply to all safety and disconnect switches installed under this contract.

B. Quality Assurance:

Acceptable safety and disconnecting switches manufacturers shall include:

1. General Electric Company
2. Square D Company
3. Westinghouse/Cutler Hammer
4. Siemens

C. Safety and Disconnect Switches:

1. Provide heavy duty type NEMA 3R enclosed 3-Pole, non-fused safety switches (Square D Model or equivalent) rated at 600 VAC with current rating as shown in the technical drawing. **IN NO CASE SHALL THE CURRENT RATING BE LESS THAN 100 AMPS.**
2. Switches shall be non-fused type unless indicated otherwise or unless required by the manufacturer of the driven equipment. Where fuses are required, provide fuses of the type recommended by the equipment manufacturer.
3. Switches shall have engraved plastic name plates indicating the load served and the load rating (Example: 15 HP, 3-Phase, 460V) screwed and glued to the enclosure.

D. Installation

1. Coordinate safety and disconnect switch installation with surrounding equipment to provide clearance and workspace based on the voltage encountered, and to insure that the switch is within sight of the controller driven equipment. **ACCESS DOORS SHALL BE ABLE TO FREELY OPEN TO A MINIMUM OF 90° FROM THE CLOSED POSITION.** A minimum clearance of three (3) feet shall be provided from the face of the door to any fixed object.

2. Group and lace conductors within enclosure with nylon tie straps.

Provide terminal strips in switches used as pump disconnects for control wiring in the circuit common with power wiring.

1.08 EMERGENCY POWER

- A. Generators with automatic transfer switches as described in City of Savannah Technical Specification – Section 16620 – Sanitary Sewer Pump Station Emergency Stand-by Power System, shall be required for Lift Stations which meet the following criteria:
 1. All Lift Stations equipped with 20 horse power pumps or larger.
 2. All Lift Stations that do not contain 90 minutes retention capacity in the collection system above the high level alarm and the overflow point. Retention capacity calculations shall be submitted to the City for review and approval to verify if Emergency Power is required. All pump stations that do not require emergency power shall be equipped with a manual transfer switch.
- B. The Manual Transfer Switch shall be Square D Model DTU363RBN (NO EQUIVALENT) for stations whose Main Power Service **DOES NOT EXCEED 100 AMPS** and shall be Square D Catalog # 82344RBN (NO EQUIVALENT) for stations whose Main Power Service is greater than 100 AMPS but **DOES NOT EXCEED 200 AMPS**. Stations requiring a Manual Transfer Switch whose Main Power Service exceeds 200 AMPS shall be as shown on the technical drawing but shall **IN NO CASE BE RATED FOR LESS THAN THE MAIN POWER SERVICE OF THE STATION**. All Manual Transfer Switches shall be rated for 600 VAC **AND** be Underwriters Laboratories Certified with a UL sticker affixed. (Note that any manual transfer switch utilizing dual breaker and/or molded case switch technology **SHALL NOT BE ACCEPTABLE**. No Service Entrance Rated manual transfer switch shall be acceptable).
- C. Each Manual Transfer Switch Rated at 100 AMPS or 200 AMPS shall be installed with a receptacle plug and associated conduit and wiring to receive power from the City of Savannah mobile power generator fleet. The generator receptacle shall be located such that mobile generators (City of Savannah fleet) may be securely located within 30 feet of the receptacle in order to power the station during emergencies. Receptacles shall be:
 1. For 240VAC Stations: Cooper Crouse-Hinds Catalog # APQC104E with AJ67 Backing Box.

2. For 480VAC Stations: Cooper Crouse-Hinds Catalog # AR1041 with AJ67 Backing Box.

1.09 WIRES AND CABLES

A. Scope of Work:

The requirements of this section apply to the wire and cable work installed under this contract.

B. Quality Assurance:

1. Acceptable Wired Cable Manufacturers shall have been in business for a minimum of five years.
2. Wires and cables manufactured more than 12 months prior to date of delivery to the site shall not be used.

3. Color Coding

- a. Color shall be green for grounding conductors and green with yellow stripe for isolated grounding conductors.
- b. The color of the circuit conductors shall be as follows:

120/208 volt, 3-phase	Phase A - Black
Or	Phase B - Red
120/240 volt, 3-phase	Phase C – Blue
	Neutral – White
	(High Leg – Orange)
277/480 volt, 3-phase	Phase A – Brown
	Phase B – Orange
	Phase C – Yellow
	Neutral – Gray

- c. All conductors shall be 600V copper, with 75 degrees C, THWN / THHN insulation. Minimum size power conductors shall be No 12 AWG and control conductors No.16 AWG. Conductors within three inches of fixture ballasts shall be rated 90 degrees C. Sizes up to #10 AWG may be stranded; sizes #8 AWG and larger shall be concentric-lay-stranded. All control conductors shall be concentric-lay-stranded.

C. Installation:

1. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway without written permission from the Engineer.
2. No more than two phase conductors, each of opposite phases for a single phase, delta system, shall be combined in a single raceway without written permission from the Engineer.
3. For each electrical connection/termination, provide a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other materials necessary to complete splices and terminations. Torque all connections according to installation instructions.
4. Splicing of feeder conductors shall not be acceptable, unless specifically indicated on the drawing. Where splicing of feeder conductors is indicated, splices shall be made using Raychem RVS splice kit and compression type butt splice.
5. All conductors shall be installed in raceways.

1.10 ELECTRICAL GROUNDING

The extent of electrical grounding work is indicated on drawings, and by requirements of this section. Grounding of electrical installations comprises both system and equipment grounding, and includes, but is not necessarily limited to: metal raceways, panel board enclosures, cable shields, junction boxes and other non-current carrying metallic parts of equipment.

A. Quality Assurance:

Acceptable Manufacturers shall include products of manufacturers regularly engaged in the production of grounding systems products. All materials shall be U.L. listed.

B. Materials and Components:

1. Except as otherwise indicated, provide for each electrical grounding indicated or required, complete assembly of materials, including but not necessarily limited to cable, wire connectors, terminals, grounding rods/electrodes, bonding jumper braid,

and other items and accessories needed for a complete installation. Where more than one type meets indicated requirements, selection is Installer's option. Where material or component is not otherwise indicated, provide products complying with NEC, and established industry standards.

2. Electrical Grounding conductors, unless otherwise indicated, shall provide bare or green insulated stranded copper electrical grounding conductors sized according to NEC. For conductors sized No. 10 AWG and smaller provide green insulated.
3. Connectors shall be exothermic weld, pressure or clamp type and shall be U.L. listed.
4. Ground Rods shall be sectionalized steel with copper-welded exterior, 3/4" dia. x 10'. A minimum of two, 10-foot sections shall be required at each ground rod location.

C. Installation of Electrical Grounding:

1. The grounding of the service equipment and separately derived systems shall be as indicated on the drawings, as specified herein and as required by the NEC.
2. Bonding of interior metal piping systems shall be as indicated on the drawings.
3. Ensure that metal-to-metal contact is made between grounding connectors and painted or coated surfaces of equipment enclosures, piping systems, etc.
4. Connections to ground rods shall be made using an exothermic weld. Other grounding electrode connections may be made using pressure connectors or clamps.
5. Metallic raceway systems shall be made electrically continuous to provide a low impedance path to ground for faults, as required by the NEC.
6. Install an equipment grounding conductor in all branch circuit and feeder raceways, sized in accordance with Article 250 of NFPA 70. Bond equipment grounding conductors to all outlet boxes with a screw used for no other purpose. Connect the equipment grounding conductor to device grounding terminals.

D. Bonding Bushings and locknuts shall be required:

1. When terminating conduits in concentric or eccentric knockouts. Bonding conductor shall be sized per the NEC.

2. For all connectors that are not U.L. listed as suitable for grounding.
3. Bushings shall be connected to the respective enclosure by an equipment grounding conductor sized in accordance with Article 250 of the NEC.

1.11 WIRING DEVICES (SWITCHES AND RECEPTACLES)

A. Scope of Work:

The requirements of this section apply to all wiring devices installed under this contract.

B. Acceptable Manufacturers shall include:

1. Hubbell
2. Arrow Hart
3. Pass & Seymour

C. Wiring Devices shall include the following:

1. Provide factory-fabricated wiring devices, in type, color and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection as determined by Installer to fulfill the wiring requirements, and complying with NEC and NEMA standards for wiring devices.
2. Provide single-pole, three-way and four-way switches as indicated. Catalog numbers listed herein are for single pole units. Other configurations shall be from the same product family.
3. Device colors shall be selected by the Engineer on an area-by-area basis.

D. Wiring Device Accessories:

1. Wall Plates shall include one piece wall plates for wiring devices, with ganging and cutouts as indicated. Provide blank plates for all un-used outlet boxes.
2. All devices shall be provided with weather proof covers. Covers shall be of the type that maintains weatherproof integrity when in-use and not in-use, as required by the NEC.

E. Installation of Wiring Devices:

Devices of the same type shown side-by-side shall be gang-mounted and installed under a common plate unless specifically noted.

1.12 RACEWAY SYSTEMS

A. Scope of Work:

The requirements of this section apply to all electrical raceway systems installed under this contract. Electrical raceway system is defined to include but not be limited to all electrical raceways, boxes, fittings, supports, and other components necessary for a complete system.

B. Rigid Aluminum Conduit:

1. Shall be utilized in all locations except where PVC is specifically required.
2. Shall include an anti-oxidant compound where applicable for conduit joints and connections.

C. Rigid Non-Metallic Conduit (SCHEDULE 40 PVC):

Shall be utilized for system and TVSS grounding conductors

D. Connectors / Couplings:

1. Connectors/couplings for use with Aluminum conduit shall be threaded type. All connectors shall be insulated throat type.
2. All connections shall be made with Myers Hubs or equivalent connectors.

E. Conduit Bodies:

Provide conduit bodies constructed with threaded conduit ends, removable cover, and corrosion resistant screws compatible with Aluminum conduits. All conduit and conduit fittings shall be a minimum of 3/4" nominal diameter.

F. Outlet Boxes:

1. Surface installation shall include cast aluminum box with threaded hubs in conjunction with metallic conduit systems.
2. Where box type specified herein conflicts with requirements of equipment to be installed, equipment manufacturer's requirements shall govern.

G. Wiring Troughs:

Troughs shall be made of code gauge stainless steel, and shall be suitable for surface mounting. Provide screw-held, removable front cover. Dimensions shall be as required for the use.

H. Raceway Installation:

1. Shall provide the right-of-way in confined spaces to piping which must slope for drainage and to larger work and which are less conformable than electrical services. However, ensure that all junction boxes and other points of access in raceway systems are located such that they are not rendered inaccessible.
2. The installation of electrical raceways shall be completed before starting installation of cables within raceways.

I. Below Grade Installations:

1. Perform all excavating, trenching and backfilling to install work of this project in accordance with applicable sections of Division 2 of the specifications and ANSI C2. Bottom of trenches shall be smooth and level to provide uniform bearing for conduits.
2. Conduits shall be secured in trench to eliminate unnecessary curvature and to prevent movement of conduits while backfilling.
3. The installation shall maintain 6" vertical separation between conduits installed one above the other. Backfill and compact each layer separately. The minimum cover requirements specified herein shall be referenced to the uppermost layer of conduits.

4. The installation shall maintain a minimum 12" (inch) horizontal and 6" (inch) vertical separation between conduits of different systems and between other underground utilities.
5. Backfill shall be free of rocks, sticks, roots, trash or other debris which may injure conduits or diminish compaction.
6. The minimum cover requirements for electrical conduits shall be 24" (inches).

J. Grounding:

Metallic raceway systems shall be made electrically continuous to provide a low impedance path to ground for faults, as required by the NEC.

K. Raceway Bends:

1. Bend radius shall comply with the NEC and the requirements of the specific cabling system installed. For television and telephone service entrance conduits installation requirements, consult with the local utility.
2. All field bends shall be made with a tool specifically intended for the purpose.
3. Tools using open flames are not acceptable for bending PVC conduit. Any section of conduit discolored or deformed in any way shall be cut out and replaced.

L. Raceway Layout:

1. Unless noted otherwise, the layout of all raceway systems is the responsibility of the Contractor.
2. Installation shall provide pull points as required by the NEC and ensure that all such points are readily accessible and not blocked by ducts, pipes, etc.

M. Supports:

1. Support all components of the electrical raceway system using wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; by machine screws, welded threaded studs, or spring-tension clamps on steel work.
2. Support individual raceways with conduit straps.

3. All supports shall be listed for the purpose and shall be compatible with Aluminum conduit. The use of makeshift supports is not acceptable. The use of wire ties or tie wraps to support raceways is unacceptable.
4. Support conduits at distances required by the National Electrical Code. Additional supports shall be provided at points of tangency of all bends.
5. Joints in conduit systems shall coincide with point of support.

N. Corrosion Protection:

1. Corrosion protection for conduits passing through concrete slabs and for the entire length below grade up to 6" above grade shall be: field-wrapping with 3M Scotchrap No. 50, 2-inches wide (minimum), with a 50 percent overlay.
2. All supporting materials shall be aluminum or provide an equivalent level of corrosion protection.

1.13 JUNCTION BOXES

A. Acceptable manufacturers shall include:

1. Hoffman
2. Robroy

B. Installation requirements shall include:

1. Installation of all junction boxes shall be that the door hinges are on the left.
2. The box shall be supported by uni-strut or equal means.
3. All connections to junction boxes shall be accomplished by aluminum Myers hubs or equal.
4. The junction box shall be capable of being locked with a padlock.
5. The junction box shall be rated for outdoor use suitable for 3R conditions.

1.14 DIALER

- A. Acceptable manufacturers shall include:

RAYCO – Verbatim

- B. Installation equipment shall include:

1. The automatic dialer shall be installed inside of a junction box on a steel or aluminum back plate with 8/32 stainless steel screws.
2. The back plate shall hold the dialer, power receptacle and telephone interface.
3. Separate conduits shall be used for power and telephone line service.

- C. Programming requirements:

The dialer will be programmed by City of Savannah personnel.

1.15 SUBMITTALS

The submittals for submersible pump, motor, guide rail system shall include, but not be limited to the following information relative to submersible pump, motor and guide rail system features:

- A. Pump:

1. Head capacity efficiency curves
2. Duty point
3. Input power (KW), voltage, phase, frequency, power factor
4. Efficiency and brake horsepower
5. Construction details: body, vane, impeller, minimum clearance between impeller and volute; vanes, pump dimensions, pump base, discharge nozzle, adapter, seals, bearings, bearing life, bolts, hooks, etc.
6. Weight
7. Centerline distance between two pumps

8. Clearance from walls, floor
 9. External coating details of materials, applications, etc.
 10. Operating and maintenance information
- B. Guide bar rail system: dimensions, material of guide bars, guide bar supports, hooks, clearance from wall, centerline distances, etc.
- C. Motor:
1. Outline dimensions, weight, construction details, terminal board, seals, shaft dimensions, torque data and structural design data for motor shaft, so cable, bearings, bearing life, etc.
 2. Where a winding over temperature device is required, provide a response curve for the temperature device.
 3. Operating and maintenance information and overhaul instructions for each motor 5 H.P. and over.

1.16 WARRANTY

- A. Warrant at 100% all parts and labor for one (1) year that covers normal wear and tear for typical sewage pump applications.
- B. The manufacturer shall provide a 100% full coverage warranty for one year (12 months) from the date of acceptance of the pump station by the City for operation and maintenance. For years 2 - 5 of the service contract, the manufacturer shall provide warranty work on a pro-rated basis. A manufacturer's service representative and the Conveyance and Distribution Director or designee shall work together to make joint resolutions of all warranty work, as well as, all other maintenance needs. The manufacturer shall also provide a service representative authorized by the pump manufacturer. Any work carried out by the authorized representative shall not violate manufacturer's warranty.
- C. A four-hour response to service call by the City shall be provided by the service representative. The service representative shall restore pump to service within five (5) working days.

- D. Service Manual - The pump manufacturer shall furnish the Owner with a minimum of six (6) service manuals for the pumps installed.
- E. The pump manufacturer shall provide the identification of manufacturer's contact person and beeper number and an alternate name and number for 24-hour availability.

1.17 SUMMARY OF DESIGN REQUIREMENTS

Equipment	< 20 H.P.	20-100 H.P.	> 100 H.P.
Motor Starter	Across the Line	Soft Starter or VFD if required by City	Soft Starter or VFD if required by City
Controls Weather Proofing	NEMA 3R	Soft Starter: NEMA 3R VFD's: Air Conditioned 3R with canopy or Air Conditioned Building	Required for VFD only See Specification 13401
Control and Status Units (CAS)	Not Required	Not Required	Required
Emergency Power and Transfer Switch	Required if < 90 minutes retention time	Required	Required
SCADA RTU	Bristol SVH2013	Bristol SVH2013	Bristol SVH2013
Flow Meter	Not Required	Required for VFD only See Specification 13401	Required for VFD only See Specification 13401

PART 2 - TESTING

2.01 CONSTRUCTION OBSERVATION

- A. The submersible pumps shall be installed and tested by the Contractor under the direction of the Engineer or his Inspector. The Engineer or his Inspector will have the right to require that any portion of the work be done in his presence, and if the work is completed after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer or his Inspector that such work is scheduled and the Engineer or his Inspector fails to appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer, his Inspector, or project representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer or his Inspector for the rejection of such materials. The Engineer or his Inspector shall have the right to mark rejected materials so as to distinguish them as such.
- B. The Contractor shall give the Project Engineer, his Inspector, or Project Representative a minimum of 48 hours notice for all required observations or tests.

2.02 ELECTRICAL REQUIREMENTS

- A. This section of the specifications covers the complete electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems. The work shall consist of, but shall not be limited to:
 - 1. Provide installation of new service, electrical distribution and control equipment for a new pump station.
 - 2. Provide coordination with utilities for power and telephone service indicated.
- B. Electrical circuits to equipment furnished under other sections of these specifications are based on design loads. If actual equipment furnished has loads other than design loads, electrical circuits and protective devices shall be revised to be compatible with equipment furnished and in compliance with the National Electric Code at no additional cost to the Owner.

- C. Equipment furnished under other sections of these specifications, to be connected under this section of the specifications, shall include, but not be limited to, pump station equipment.
- D. The Contractor's attention is directed to other sections of these specifications where equipment requiring electrical service is specified. It is also necessary to be aware of the scope of work under this section of these specifications requiring electrical service and connections to equipment specified elsewhere.

2.03 CODES AND PERMITS

All electrical work shall comply with the following:

- A. The National Electric Code (N.F.P.A. 70) - 2003 Edition.
- B. Regulations of the local utility company with respect to metering and service entrance.
- C. Applicable municipal electrical ordinances.
- D. All fees, permits, and certificates of inspections required by the public authorities having jurisdiction shall be paid by the Contractor.

2.04 SERVICE

- A. Electrical service shall be 3 phase, 4W, 115/230 or 3 phase, 4W, 277/480. Coordinate electrical service location with local utility.
- B. Meter sockets, cabinets for metering transformer, grounding, conduit and conductors for metering shall be installed by the Contractor in accordance with the standards of the Utility Company. Coordinate installation of metering equipment with Utility Company to provide a complete metering system.
- C. Provide surge protection at the service in accordance with IEEE 587 as shown on the drawings and as specified herein.

2.05 POWER SERVICE EQUIPMENT CONNECTIONS

All equipment requiring electrical connections shall be connected under this section of these specifications. Where an electrical connection to equipment requires specific locations, such location shall be obtained from shop drawings. Do not scale drawings for location of conduit stub-ups to service specific equipment.

- A. Circuit Breakers - Circuit breakers shall be bolt-on, quick-made, quick-break, thermal magnetic type of the ampacity and interrupting ratings as shown on the drawings. Multi-pole breakers shall be common internal trip. Tie handles are not acceptable. All breakers shall be in NEMA 4X stainless steel enclosures. Breakers shall be ambient compensated type at 50 degrees C. Label breakers used for service disconnects. Provide ground lugs in all enclosures. Breakers shall be NEMA rated.
- B. Transfer Switch – The transfer switches shall be three position, center off and rated for the incoming service for both voltage and amperage.
 - 1. Manual Switches – The manual switch shall be used when there is not a permanently mounted generator. The manual transfer switch shall be equivalent to Square D Model HU 363 RB. All manual switches shall be 600 volt rated.
 - 2. Automatic Transfer Switch – An automatic transfer switch shall be used when there is a permanently mounted generator. The transfer switch shall be equivalent to Onan Model OTPC. The switch shall have two sets of convenience contacts rated for 10A continuous duty.
- C. Disconnect Switches - All disconnect switches shall be non-fusible 600 volt rated, heavy duty type in NEMA 4X Stainless Steel enclosures, 3 pole, of the ampacity shown on the drawings with ground lug and locking capabilities.
- D. Conduit Systems - All conduits shall be rigid aluminum unless in contact with the earth. Conduits in contact with the earth shall be Schedule 40 PVC. Where conduits turn up from below grade, provide rigid aluminum elbows. Wrap all conduits entering or exiting concrete with vinyl all-weather tape. Seal all conduits entering electrical equipment from below grade and wet well with electrical putty. Do not seal the conduits inside of the wet well. All aluminum conduit connections shall be accomplished with aluminum hubs i.e. Myers, T and B or equal.
- E. Outlet Boxes - All outlet boxes and junction boxes shall be weatherproof with weather proof covers.
- F. Conductors - All conductors shall be copper, type THW and THWN, or THHN minimum size No. 12. All conductors shall be color-coded as follows: 230/115 volt, 3 phase, 4 wire system-Phase A: Black, Phase B: Red, Phase C: Orange (High Leg), Neutral: White, Ground: Green. 480/277 volt, 3 phase, 4 wire system - Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Grey, Ground: Green. Provide on all branch circuit conductors, manufacturer's standard vinyl cloth self-adhesive cable markers of the wrap

around pre-numbered plastic-coated type. Number all conductors to show circuit identification and identify each control wiring conductor at each termination and in each accessible enclosure. All conductors in enclosures shall be grouped and laced with nylon tie straps. There shall be no conductor splices. Connector selection shall be determined by Installer to comply with the requirements of NEC, the National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure products serve the intended functions. Install only one conductor under terminal of individual circuit breakers.

- G. Grounding - The electrical system shall be grounded. All raceways shall contain an equipment grounding conductor to provide a low impedance path for grounded faults. Ground the neutral at the service disconnect to a ground rod system. Ground rods shall be 3/4" copper clad rods 10' in length. Top of rods shall be 12" below grade. Connections to rods shall be by chemical weld process. Provide up to three rods so that the resistance to ground is below 25 ohms.
- H. Surge Protection - Surge protection for 3 phase, 4W, 115/230 volt system shall be Joslyn 1452-45 or equivalent, and for 3 phase, 4W, 277/480 volt system shall be Joslyn 156-45 or equivalent. Provide manufacturers product data and connection diagrams. Enclose in a separate NEMA 3R and mount as close as possible to service head, see Detail S-25. Surge protection equipment shall be mounted where shown on the drawings. Connections shall be made to service entrance conductors with conductors as recommended by the manufacturer. Grounding shall be provided in accordance with manufacturer's recommendations and requirements.

2.06 ACCEPTANCE OF PORTIONS OF THE WORK

The Owner reserves the right to accept and use any portion of the work whenever it is considered to his interest to do so. The Engineer or his Inspector shall have power to direct in what area the Contractor shall work and the order thereof. The Contractor shall complete the Lift Station Data sheets (5) at the end of this section fully prior to the Owner's acceptance.

2.07 PUMP TEST

- A. Testing performed upon each pump shall include the following inspections:
 - 1. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.

2. Prior to submergence, each pump shall be run dry to establish correct rotation.
 3. Each pump shall be run submerged in water.
 4. Motor and cable insulation shall be tested for moisture content or insulation defects.
- B. Upon request, a written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.
- C. Each pump shall be tested in the field to provide a field certified pump curve with the initial draw down documentation submitted in accordance to lift station data sheets shown in Subpart 2.10 of this specification.
- D. The pump(s) shall be rejected if the above requirements are not satisfied.
- E. Start-up Service:

The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for an 8-hour working day(s) at the site to inspect the installation and instruct the owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:

1. Megger stator and power cables.
2. Check seal lubrication.
3. Check for proper rotation.
4. Check power supply voltage.
5. Measure motor operating load and no load current.
6. Check level control operation and sequence.
7. Submit a completed Subpart 2.10 for approval by the Engineer.
8. Pumps shall clear the hatch of the wet well top without impedance.

During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.

F. Factory Service:

Factory-Approved service facilities with qualified factory trained mechanics shall be available for prompt emergency and routine service. The pump manufacturer shall warrant the pumps in writing against defects in workmanship and material for a period of five (5) years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units. Warranty shall cover both parts and labor on a pro-rated basis after the first year. The first year warranty shall cover 100 percent labor and materials cost.

G. Operation and Maintenance Manuals:

The manufacturer shall furnish to the owner six (6) sets of its Operation and Maintenance Instruction Manuals and parts List.

2.08 ELECTRICAL SYSTEMS

A. Electrical Grounding:

Upon completion of installation of electrical grounding system, test resistance of each ground rod installation using the "Fall of Potential" method. Ground resistance shall be measured in normally dry conditions not less than 48 hours after rainfall. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms or less by driving additional sections of ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance. Provide forms to record the data as the tests are conducted. Forms shall be signed by the person conducting the test.

B. Electrical Systems:

Electrical Systems Operational Tests - At the time of final inspection, all electrical systems shall be tested for compliance with the Specifications. The Contractor shall provide personnel and equipment required to perform these tests. The Engineer or his representative shall observe the tests.

Equipment covers (i.e. panel board trims, motor controls, device plates, and junction box covers) shall be removed as directed for inspection of internal wiring. All circuits throughout the project shall be energized and shall be tested for operation and equipment connections in compliance with contract requirements.

2.09 SCADA REMOTE TERMINAL UNIT (RTU) STARTUP / TEST

- A. The contractor shall provide for complete check out of field wiring, start-up, proper operator of the RTU, interface with field transmitters and control cabinet, and verification of proper radio operation by the SCADA RTU supplier. The contractor shall provide a certificate of verification to the City of Savannah and signed by the supplier that the unit has been field verified as described above and that the unit will perform as intended under this specification.
- B. Antenna: The City of Savannah at start-up will conduct an inspection of installation of Antenna to include the following:
 - 1. Mounting (Proper hardware)
 - 2. Grounding (Proper Grounding Techniques, Cad-welding)
 - 3. Cable Installation (Proper Cable Hanger Clips, Proper Spacing of Cable Hangers, SWR, Reflective Power)
 - 4. Signal Strength (Min -88)
 - 5. Connector End installation (Weather Proofing).

Any problems found by Radio Shop will require immediate action to fix and station will not be allowed to pass inspection until problems are fixed and verified by Radio Shop.

2.10 LIFT STATION DATA SHEETS

LIFT STATION NAME: _____ Number: _____

Address: _____ Cross Street: _____

Station Power:

Voltage: _____ Phase: _____ Amperage: _____ Gen Set: _____ Plug: _____

Sub Station: _____ Feeder Number: _____

Transformer Number: _____ Account Number: _____

Conveyance Information:

Pumps to: _____ Serves: _____

Equipment:

RTU:

Model Number: _____ Serial Number: _____ DS

Controls:

Manufacturer: _____ Model Number: _____

Serial No.: _____ Vendor: _____

Contract Services: _____ Phone Number: () -

Contact: _____ Emergency Number: () -

Pumps:

Manufacturer: _____ Model Number: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

GPM: _____ TDH: _____

Vendor: _____ Phone Number: () -

Contract Services: _____ Phone Number: () -

Contact: _____ Emergency Number: () -

Gen Set:

Manufacturer: _____ Model Number: _____
Serial Number: _____ KVA: _____ M.C/B: _____
Vendor: _____ Phone Number: () - _____
Contract Services: _____ Phone Number: () - _____
Contact: _____ Emergency Number: () - _____

Transfer Switch:

Manufacturer: _____ Model Number: _____
Serial Number: _____ KVA: _____
Vendor: _____ Phone Number: () - _____
Contract Services: _____ Phone Number: () - _____
Contact: _____ Emergency Number: () - _____

Odor Systems:

Manufacturer: _____ Model Number: _____
Vendor: _____ Phone Number: () - _____
Contract Services: _____ Phone Number: () - _____
Contact: _____ Emergency Number: () - _____

Equipment: _____

By-Pass: Type: _____
Manufacturer: _____ Model Number: _____
Vendor: _____ Serial Number: _____
Description: _____

Contract Services: _____ Phone Number: _____
Contact: _____ Emergency Number: () - _____

Building Type: _____ Bldg Size (L x W): _____
Finished Floor Elevation (NAVD '88): _____ # of Floors: _____ # of Rooms: _____
Fence Type & Height: _____ Lot Size (L x W): _____

Gates: Number Gates: _____ #1: _____ x _____ #2: _____ x _____ #3: _____ x _____
Sump Pump: _____ HP: _____ GPM: _____ TDH: _____ Voltage: _____ Phase: _____

Fan: _____ HP: _____ RPM: _____ FPM: _____ Voltage: _____ Phase: _____
Heater: _____ BTU: _____ Voltage: _____ Phase: _____ Wattage: _____
A/C: _____ BTU: _____ Voltage: _____ Phase: _____
Hoist: _____ Tons: _____ ft/sec: _____ Clearance: _____ ft Length: _____ ft
Electric? Y/N Volts: _____ Phase: _____

Miscellaneous Equipment:

Description: _____	Voltage: _____	Phase: _____
Description: _____	Voltage: _____	Phase: _____
Description: _____	Voltage: _____	Phase: _____
Description: _____	Voltage: _____	Phase: _____

Comments: _____

Data: Last Update: _____
Date: _____ / _____ / _____
Station Construction: \$ _____
Start Up Date: _____ / _____ / _____
Warranty Description: _____
Warrantor: _____
Expires: _____ / _____ / _____

Wet Well Data:

Square _____	Rectangular _____	Circular _____	(Check Applicable Shape)
Length: _____ feet _____ inches		Diameter: _____ feet _____ inches	
Width: _____ feet _____ inches		Depth: _____ feet _____ inches	

Elevation at center of Pump Motor: _____ feet Elevation at top of Wetwell: _____ feet
Elevation at bottom of Inflow Pipe: _____ feet Inflow Pipe Diameter: _____ inches
Elevation at top of lowest Manhole: _____ feet Elev. of lowest House Lateral: _____ feet

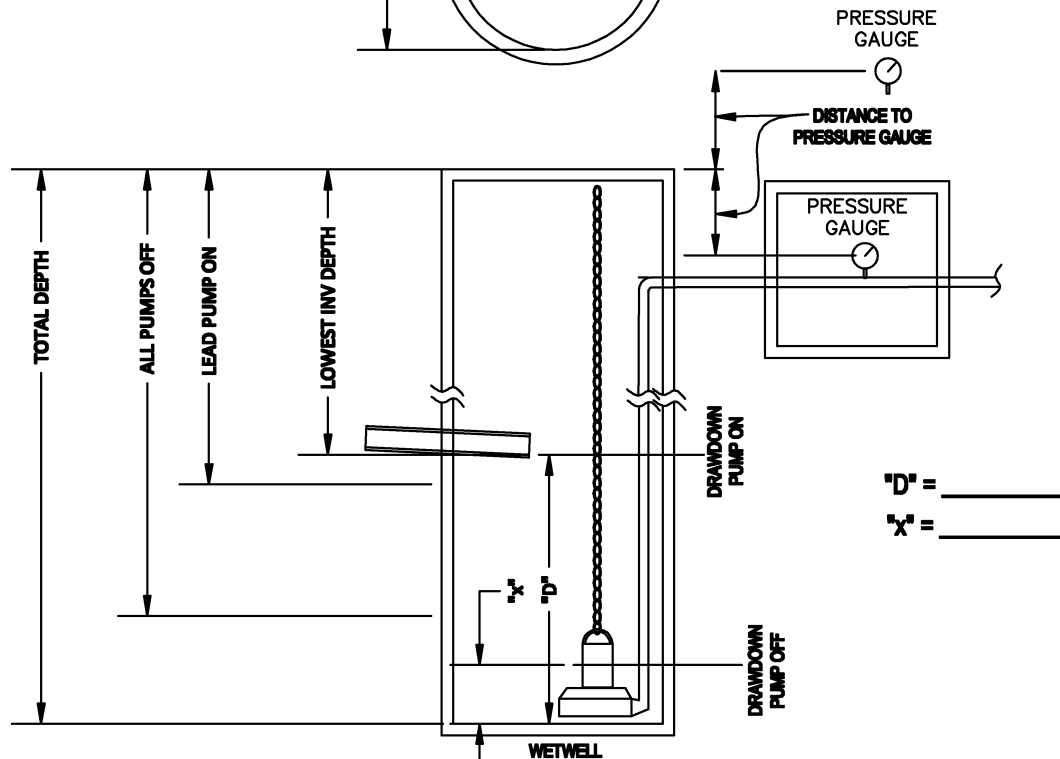
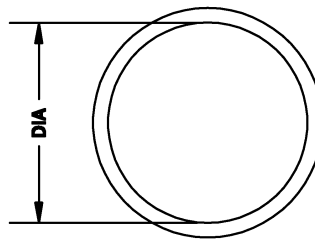
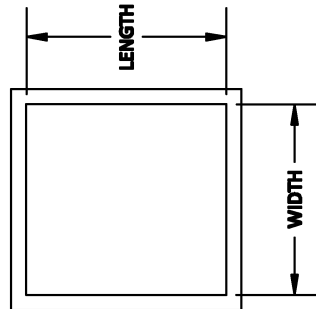
Pump Guide Bars:

Total Length: _____ feet _____ inches Dia.: _____ inches Middle Bracket: Y / N
Pump Base: _____ inches
Station Force Main Size: _____ inches By-pass Cam-lock Size: _____ inches

Remarks: _____

LIFT STATION DRAWDOWN SKETCH

LIFT STATION NO. _____



"D" = _____

"X" = _____

PUMP MODEL: _____ VOLUME (GAL/FT): _____
 PUMP HP: _____ AVG PUMP RATE (GPM): _____
 IMPELLER (mm or Code): _____ INFLUENT FLOW AVG (GPM): _____
 VOLUTE (In): _____

Date: _____ Lift Station #: _____ Weather: Dry or Wet By: _____

By: _____

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PART 3 – FINAL INSPECTION

3.01 FINAL INSPECTION / ACCEPTANCE

A. Field Pumping Test:

1. The Water and Sewer Conveyance and Distribution Director or his representative shall be present at time of this test. Perform a minimum of two pump tests with each pump for a minimum of three flow discharges with each pump pumping with the discharge valve set as follows:
 - a. Closed
 - b. Full Open
 - c. Throttled
2. During final inspection, the contractor, in the presence of the Owner's representative, shall remove each pump using the hoist beam, set the pump on the top slab, reinstall the pump and start up the pump with no interference or excess force.

B. Dry Pumping Test:

The pump will be tested in one of two ways; Facility Test or Site Test:

1. Facility Test:

A facility designed for testing of pumps and motor, with control over liquid level, head conditions, current, voltage and temperature, also monitoring and recording of data. Snore conditions may occur for an estimated period of 4 hours ~~for~~ or 45 seconds.

2. Site Test shall be performed as follows:

- a. Current and pump/motor temperature shall be recorded.
- b. Pump to be set as designed in station on base.
- c. Force main shall be plugged.
- d. By-pass valve open, with a cam-lock pipe connected shall be in place so water can flow back into wetwell.
- e. Wet well shall be filled to centerline of volute (more water may be added to maintain centerline).

- f. Pump shall be placed on line.
- g. By-pass valve shall be adjusted to meet designed duty point.

Snore may occur due to turbulence and liquid level pump down. The Water and Sewer Conveyance and Distribution Director reserves the right to have this test performed for each pump by the manufacturer and/or supplier of the pumps.

3.02 PERSONNEL REQUIRED FOR INSPECTION

General Contractor

City Engineering Departments

Conveyance and Distribution applicable personnel

Civil and Electrical Engineering Consultants

Pump and Control Manufacturer

Emerson / Bristol Babcock for SCADA

END OF SECTION 11100